AnoDDPM: Anomaly Detection with Denoising Diffusion Probabilistic Models using Simplex Noise

Year: 2022 | Citations: 370 | Authors: Julian Wyatt, Adam Leach, Sebastian M. Schmon, Chris G. Willcocks

Abstract

Generative models have been shown to provide a powerful mechanism for anomaly detection by learning to model healthy or normal reference data which can subsequently be used as a baseline for scoring anomalies. In this work we consider denoising diffusion probabilistic models (DDPMs) for unsupervised anomaly detection. DDPMs have superior mode coverage over generative adversarial networks (GANs) and higher sample quality than variational autoencoders (VAEs). However, this comes at the expense of poor scalability and increased sampling times due to the long Markov chain sequences required. We observe that within reconstruction-based anomaly detection a full-length Markov chain diffusion is not required. This leads us to develop a novel partial diffusion anomaly detection strategy that scales to high-resolution imagery, named AnoDDPM. A secondary problem is that Gaussian diffusion fails to capture larger anomalies; therefore we develop a multi-scale simplex noise diffusion process that gives control over the target anomaly size. AnoDDPM with simplex noise is shown to significantly outperform both f-AnoGAN and Gaussian diffusion for the tumorous dataset of 22 T1-weighted MRI scans (CCBS Edinburgh) qualitatively and quantitatively (improvement of +25.5% Sørensen–Dice coefficient, +17.6% IoU and +7.4% AUC).